

It is not in my power to give an account of the water-birds of the Loktak Lake, on and around which both swimming and wading birds are extraordinarily abundant. On this subject Hume's paper in *Stray Feathers*, Vol. XI, should be consulted. I have not seen any other place in India where such enormous swarms of ducks and geese could be observed on the water as was the case in February on this lake, and wading birds were almost as abundant in the surrounding swamps. Some of the latter, notably the smaller Herons, the Open-bill (*Anastomus oscitans*) and the Glossy Ibis (*Plagadis falcinellus*), were proved by examination of their stomach-contents to be feeding mainly on aquatic molluscs, and even the ducks and geese must destroy enormous quantities of molluscan spawn and young with the weeds on which they depend mainly for their food-supply.

Otters are said to be abundant, but no specimens were obtained.

The fauna of the Loktak Lake must, therefore, be regarded as paludine rather than lacustrine. It is comparable to that of the marginal zone of the Inlé Lake rather than to that of the central region. Even from the former, however, it differs notably. The great abundance of different species of small bottom-haunting fish, the greater poverty of the arthropod fauna and the absence of several molluscan genera (*Pachylabra*,<sup>1</sup> all the Hydrobiidae, *Segmentina*, etc.) usually found in such situations are noteworthy features, and may be correlated directly with the superabundance of vegetation and indirectly with the composition of the water and therefore, still more indirectly, with the geological formation of the surrounding country and the meteorology of the valley. The absence of extreme specialization in the aquatic fauna may be put down partly to the same causes and partly to the absence of complete geographical isolation, while the curious fact, amply illustrated in the following paper, that, though the Imphal River belongs to the Irrawadi system and is cut off by high ranges of mountains from those of Assam, nevertheless the aquatic molluscs are essentially Assamese and include very few Burmese species—this fact would at any rate suggest that comprehensive physiographical changes have taken place in the Manipur valley and the surrounding hills at a date geologically not remote.

## THE PROSOBRANCHIA.

By N. ANNANDALE.

This order is represented in the aquatic and amphibious fauna of Manipur by eleven species, belonging to the families Hydrobiidae, Viviparidae, Melaniidae and Ampullariidae. With one exception, that of the Viviparid genus *Lecythoconcha*, the genera are those usually found in the tropical districts of India, and this section of

<sup>1</sup> The place of this genus is taken to a large extent by gigantic Viviparidae.

the fauna may be regarded on the whole as normal in composition. Moreover, with the exception of the Viviparidae, the species are but little modified. The majority of them are, indeed, of wide or fairly wide geographical distribution, and, considering the isolation of the valley, perhaps less remarkable than might be expected.

The Viviparidae, however, are not only to a large extent endemic in the valley, to which two of the four species are apparently confined, but also peculiar in anatomical structure as well as in shell-sculpture. Two of the four are ornamented with smooth spiral ridges on the shell, while I have been obliged to institute for a third a new genus, founded mainly on the structure of the operculum and mantle. This species (*Lecythoconcha lecythis*) is, however, by no means endemic in Manipur, having a wide range in south-eastern Asia and belonging to a group essentially Chinese in distribution.

#### Family HYDROBIIDAE.

Three species of this family have been found in Manipur, all in the valley. Two belong to a genus recently described as new under the name *Digoniostoma*, but widely distributed in India proper and Assam; while the third represents the subgenus *Alocinma*, recently set up as a subgenus of *Amnicola* by Dr. Baini Prashad and myself with a Persian species as type. This genus has a wide range, which extends at any rate from Mesopotamia to Upper Burma.

The three genera *Bithynia*, Leach, *Digoniostoma*, Annandale, and *Hydrobioides*, Nevill, and the subgenus *Alocinma*, Annandale and Prashad, are so closely allied and so liable to be confused that it will be well to give a key to them here. The anatomy of all is very similar and they are distinguished mainly by the structure of the aperture of the shell and of the operculum.

- A. Periostrone continuous; outer lip neither thickened nor attenuate; umbilicus closed or rimate, without an oblique channel running forward on the lower surface of the shell; *operculum with a distinct but paucispiral figure situated near the middle of the lower part and visible on both surfaces* ... *Alocinma.*
- B. Operculum concentric, with no spiral figure on the lower part or visible on both surfaces.
  - i. A well-defined oblique channel running forwards from the umbilicus on the lower surface of the shell.
    - a. Outer lip thin, not produced or angulate at its inner extremity ... *Bithynia.*
    - b. Outer lip slightly thickened, produced and angulate or subangulate at its inner extremity ... *Digoniostoma.*
  - ii. No well-defined channel running forwards from the umbilicus. Outer lip distinctly thickened, but not produced at its inner extremity; a supplementary varix often present outside the thickened lip. *Hydrobioides.*

Genus *Amnicola*, Gould and Haldeman.Subgenus *Alocinma*, Annandale and Prashad1919. *Alocinma*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 23.1920. *Alocinma*, Annandale, *ibid.*, XIX, pp. 43, 44.

I still think it more convenient to regard *Alocinma* as generically identical with *Amnicola*, for the soft parts and radula are closely similar and the operculum intermediate between that of *Amnicola* (s.s.) and that of *Pseudamnicola*.

*Amnicola* (*Alocinma*) *orcula* (Frauenfeld).1876. *Bithynia orcula*, Hanley and Theobald, *Conch. Ind.* pl. xxxviii, figs. 8, 9.1885. *Bithynia orcula*, Nevill, *Hand List Moll. Ind. Mus.* 11, p. 36.1919. *Amnicola* (*Alocinma*) *orcula*, Annandale and Prashad, *op. cit.*, p. 24.

Frauenfeld was the first to describe this species, though he gave it Benson's name. It is one of the commonest molluscs of the Indo-Gangetic plain and is replaced in Peninsular India by *A. stenothyroides* (Dohrn), which is hardly more than a local race. Manipur is apparently the limit of the range of the species in a south-easterly direction. It has not been found in Burma. The radula, operculum and male organ closely resemble those of *A. sistanica*. The last, however, varies in the proportions of its different parts, as it does also in other members of the family, in accordance with its condition when the animal is killed.

Nevill has named several "varieties" and "subvarieties". Of these the only one that concerns us here is his "var. *producta* (? dist. sp.)". It has a much narrower and more elongate shell than the *forma typica*, with which it often occurs, but in my opinion is no more than an aberration.

*A. orcula* is abundant in ponds and swamps in the Manipur valley. In the day-time it is to be found both on mud at the bottom and among water-plants, but in the evening rises to the surface and crawls, shell downwards, on the surface-film. The form *producta* is not uncommon with the *forma typica* in Manipur.

Genus *Digoniostoma*, Annandale.1920. *Digoniostoma*, Annandale, *Ind. Journ. Med. Research*, VIII, p. 104.

The chief characteristics of this genus have already been mentioned in the key on a preceding page. I did not separate it from *Bithynia*, Leach, in my recent paper on the Indian species confused under the name of that genus, though I was aware of certain peculiarities in the shell, but I have to thank Mr. A. S. Kennard for drawing my attention to certain of the differences. These lie in the structure of the peristome. The lip is not so distinctly thickened as in *Hydrobiooides* and a supplementary varix is never present. The columellar callus is thick, broad and prominent and always has a laminated appearance. At the point at which it

meets the lip a distinct projection is formed. This feature is distinct in *D. ceramcopoma* (Benson), which I propose as the type-species of my new genus, in *D. lutca* (Gray), *D. pulchellum* (Benson) and the new species here called *D. textum*.

***Digoniostoma pulchellum* (Benson).**

1830. *Paludina pulchella*, Benson, *Journ. As. Soc. Bengal* V, p. 746.  
 1876. *Bithynia pulchella*, Hanley and Theobald, *Conch. Ind.* pl. xxxviii, figs. 5, 6.  
 1885. *Bithynia pulchella*, Nevill, *Hand List Moll. Ind. Mus.* 11, p. 35.

This species is common in all parts of the plains of Assam but has not been found in Burma.

The aperture of the shell and the surrounding parts are not quite so characteristic of the genus as in some species, for the columella projects less and the umbilicus being practically closed, the channel running forward from it is not so deep or well-defined. The angle at the inner extremity of the lip is also blunted or rounded off. The operculum is distinctly concentric and its external surface is divided into several distinct areas by prominent concentric ridges.

Our specimens from Manipur are smaller than those from northern Assam. Several of them are in an interesting stage, having evidently been killed at a period of active growth. In these shells the lip is still thin as in *Bithynia* and the operculum, which in the fully formed shell cannot be retracted, is drawn in as far as the beginning of the new addition to the shell. I have observed a similar stage in shells of *Hydrobioides*.

The soft parts and radula are very like those of the new species (*D. textum*) now to be described (fig. 1).

*D. pulchellum* is much scarcer in the Manipur valley than either *A. orcula* or *D. textum*. We took it only in ponds at Imphal. In habits it resembles these two species.

***Digoniostoma textum*, sp. nov.**

The shell is not more than 8 mm. high and 5 mm. in maximum diameter. It is broadly and irregularly ovate in outline with the apex minutely and obliquely flattened, the whorls moderately convex and not at all angulate externally and the inner anterior extremity pointed and produced obliquely. There are  $4\frac{1}{2}$  whorls, of which the first whorl and a half are minute and inconspicuous. The others increase evenly but rapidly in size. They are slightly flattened above and more distinct in the inner than in the outer outline. The suture is oblique, linear, and, except at the apex, impressed. The spire is shorter than the body-whorl in dorsal view. Its whorls are oblique and transverse, more than twice as broad as deep. The body-whorl in dorsal view is obliquely trumpet-shaped, expanding greatly towards the outer margin. The aperture is relatively long, rather narrowly oval, slightly oblique, less than  $\frac{2}{3}$

as long as the body-whorl. The outer lip turns inwards above and meets the inner callus at an angle slightly greater than a right angle. The columellar border is arched, prominent and thick, with its lamellar structure well developed. The umbilicus is almost closed but the channel running forward from it well defined. The inner lower angle of the lip is strongly developed.

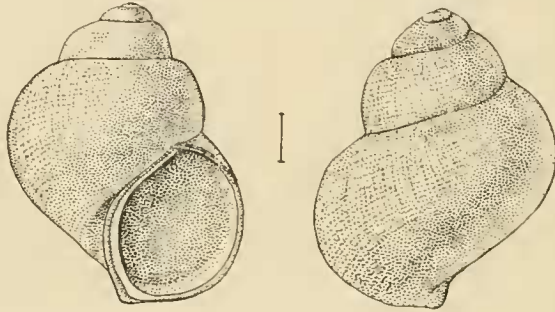


FIG. 1.—Type-shell of *Dignostoma textum*.

The operculum is large, subrhomboidal, moderately thick, testaceous-translucent when fresh but soon becoming white and dull. There is a very delicate brownish periostracum on the external surface, which is rather deeply concave in the central region. The nucleus is subcentral, but situated slightly in front of the middle point. The sculpture is poorly developed but several faint concentric ridges can be detected round the periphery, while the nucleus retains traces of a spiral origin. The internal surface is convex and faintly granular, with a rather broad flattened border on the outer margin.

The radula is like that of a typical *Bithynia*. The specific characters of the teeth are well shown in fig. 2.

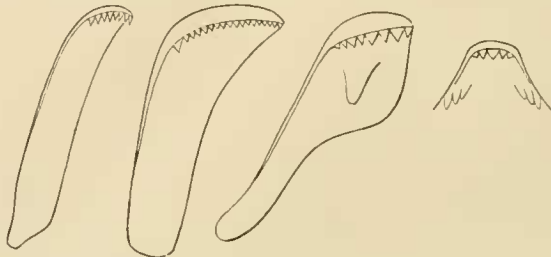


FIG. 2.—Radular teeth of *Dignostoma textum*.

The external soft parts are dull greenish speckled with yellow. The feet, snout and tentacles are normal, the foot is rather shorter and the operculiferous lobe larger than some species. The male organ is densely pigmented, long, coiled, tapering and produced to a very fine point. Its subsidiary appendage is colourless, long and slender, cylindrical and with a simple cup-shaped depression at the



tip. It projects outwards towards the left at a right angle and originates near the base of the inner side of the penis.

*Type-series*.—No. 11860/2 Zool. Surv. Ind. (*Ind. Mus.*)

*Habitat*.—The species is abundant and generally distributed in the Manipur valley, outside which it has not been found. It lives in small sluggish streams, pools and swamps in the plains but was not found in the Loktak Lake. It crawls slowly on the lower surface of floating grass-stems and water-weeds and can float shell downwards on the lower side of the surface film. It is resistant to drought, and individuals brought dry to Calcutta revived on being placed in water after over a fortnight's desiccation. The shell is usually covered with mud.

*Affinities, etc.*—As in most Indian species of the genus the shell is somewhat variable in shape and the spire is more produced in some individuals than in others. In the majority, however, it is relatively short and has a rather close resemblance in general outlines to some species of *Alocinma*. In sculpture it closely resembles *A. travancorica* (Benson). The structure of the aperture and the adjacent parts is, however, eminently characteristic of *Digonios-toma* and the operculum, though like that of *Hydrobioides nassa* it shows traces externally of a spiral origin in the nuclear region, is much less spiral than in *Alocinma*. I am not acquainted with any species to which *D. textum* is closely related.

#### Family VIVIPARIDÆ.

This family may almost be called the dominant one among the Gastropods of the Manipur valley, for not only are individuals extremely abundant, but the two commonest species attain a size quite exceptional. Four species are represented in our collection, of which two are rare, while two occur in all suitable bodies of water in very large numbers.

#### *Vivipara*, Montfort.

1920. *Vivipara*, Annandale, *Rec. Ind. Mus.* XIX, p. 112.

In the paper cited I have separated the Indian species of this genus into four groups, the *Viviparæ bengalenses*, the *Viviparæ oxytropides*, the *Viviparæ dissimiles*, and the *Viviparæ siudicæ*. With the exception of the last, each of these groups is represented in the Manipur fauna by one species and all but one (*V. oxytropis*) of these species are apparently endemic.

#### VIVIPARÆ BENGALENSES.

This group has as its Manipur representative a hitherto undescribed species quite distinct from both *V. bengalensis* (Lamarck), the races and phases of which are scattered over most parts of the Indian Empire, and *V. nagaensis*, Prestou, which is known only from the Naga Hills. For this new species I propose the name:—

**Vivipara crassispiralis**, sp. nov.

(Plate IV, fig. 1.)

The shell is ovate-conical, rather bluntly acuminate, from  $1\frac{1}{4}$  to  $1\frac{3}{8}$  times as high as broad, thin, of an almost uniform bright olive-green but with faintly darkened spiral bands, with the whorls tumid and obliquely, rather broadly flattened outside the

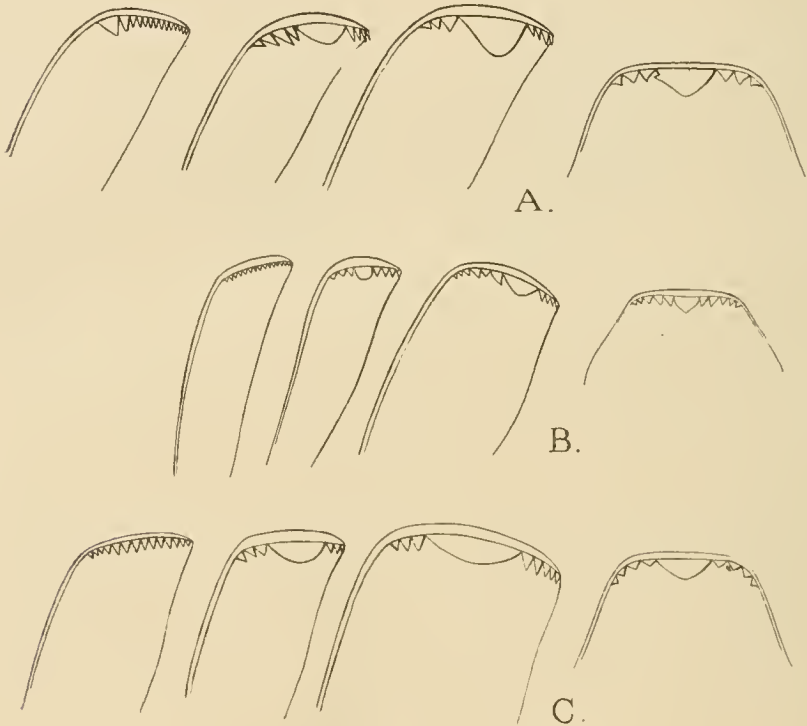


FIG. 3.—Radular teeth of Viviparidae.

A.—*Vivipara crassispiralis*.B.—*V. oxytropis*C.—*Lecythoconcha lecythis*.

suture, which is linearly impressed. The sculpture consists of prominent spiral ridges, of which two are visible on the penultimate and antepenultimate whorls and three on the upper part of the body-whorl, and of numerous fine spiral lines crossed at fairly regular intervals by rather coarser oblique vertical lines. The ridges are nearly solid. There are  $4\frac{1}{2}$  whorls in all when the shell is complete. The first whorl and a half are smooth except for the fine lines. All increase in size gradually and evenly. The body-whorl is transverse and oblique, with its anterior margin strongly sinuate. It shows no tendency to be biangulate and the peripheral ridge is hardly stronger than the others above it; below it there

are about six rather more delicate spiral ridges. The mouth is rather small, suboval, oblique, and from  $1\frac{1}{4}$  to  $1\frac{3}{4}$  times as high as broad. It is evenly rounded below and obliquely, bluntly pointed above. The peristome is not continuous. The outer lip is thin, evenly and broadly arched. Its outline is rendered irregular by the ends of the spiral ridges. The columella is arched, slightly laminated and retroverted, of a bluish white colour. The umbilicus is rimately perforate. The interior of the shell is faintly tinged with bluish white.

The following are the measurements in millimetres of the five shells in the type-series:—

Height	..	..	26	26	23	21	20
Max. diam.	..	..	20.5	19	17	17	16
Height of aperture (oblique)			14	12.5	12	12	12
Max. diam. of aperture	..	..	11	9.5	8.5	9	7.5

The *operculum* is very thin, of broadly ovate outline, broadly and rather deeply concave on the external surface. The scar, which is situated much nearer the inner than the outer margin, is not greatly thickened but much deeper in colour than the rest of the structure and surrounded by an opaque whitish ring. The external sculpture consists of fine concentric striae, the margin is very thin and slightly recurved.

The *edge of the mantle* is thin, with a fairly well-developed superior sphincter muscle. Minute papillae are present on the margin, corresponding in position to the coarse spiral ridges of the shell, but they are rather hard to detect in preserved material.

The *radula* is like that of *V. bengalensis*, but the lobular central process of the central and marginals is triangular and the lateral denticulations of the same teeth fewer and shorter.

*Type-series*.—No. M 11738/2 Zool. Surv. Ind. (*Ind. Mus.*).

*Locality*.—The five shells which form the type-series were purchased in the bazaar at Imphal in a living state by Mr. Sundar Lal Hora with living specimens of *Paludomus pustulosa*, sp. nov. They were said to have been brought from the Chakpi stream in the south of the Manipur valley near the Burmese frontier. I have not seen living specimens.

*Affinities*.—The species is allied to *V. bengalensis doliaris* from Burma but the spiral ridges are much more strongly developed and less darkened, the body-whorl is not at all biangulate and the colour is brighter and deeper. Unfortunately we know nothing of its habits with certainty but its occurrence with a *Paludomus* of the *conica* group would suggest that it is possibly fluviatile rather than paludine. It has no real relation to *V. oxytropis* in spite of its superficial resemblance on account of the thickened spiral ridges; for the base of the shell is not at all flattened but distinctly tumid, while the apical portion is conoidal rather than conical, and the peripheral ridge is no more prominent than the others. The resemblance to certain Chinese and Philippine shells is probably quite superficial.



## VIVIPARAE OXYTROPIDES.

**Vivipara microchaetophora**, sp. nov.

1877. *Paludina bengalensis* var. *cingulata* (in part), Nevill, *Cat. Moll. Ind. Mus.* F., p. 29.  
 1885. *Paludina bengalensis* subsp. *cingulata*, subvar. Nevill *Hand List Moll. Ind.* II, p. 22.

Although this species was not found in Manipur it may be conveniently described here as it has a distinct bearing on the origin of *V. oxytropis*, one of the most characteristic of the Manipur molluscs.

The *shell* is small, thin, sharply acuminate, somewhat elongate and imperforate. It is divided into two regions by a blunt peripheral ridge on the body-whorl, above which it is narrowly conical, while below it is broad and rounded. There are  $5\frac{1}{2}$  whorls. Those of the spire are very slightly convex but obliquely and not very broadly flattened above. The suture between them is not strongly impressed except sometimes in old shells above the body-whorl, and they increase in size gradually and evenly. The body-whorl is more swollen but transverse and less than twice as deep on the outer as on the inner margin. The aperture is of moderate size, subrhomboidal, rather narrow, higher than broad, pointed above and often subangulate below, slightly oblique. The peristome is complete, the outer lip sharp, the columella strongly arched, with its fold narrow and by no means prominent. The region to the left of the mouth in the natural position of the shell slopes upwards somewhat abruptly and is very slightly convex. In young adult shells the colour is a translucent olivaceous yellow, as a rule tinged with green on the body-whorl. The apical whorl and a half are dull purple and the others are marked with numerous fine spiral bands of the same colour. The suture is also deeply tinged with purple. The inside of the shell is white and the peristome is linearly edged with black. In old shells the distinctive colouration is apt to be obscured by a general blackening of the surface and this sometimes occurs in quite small specimens. On the body-whorl there is not as a rule any very definite trace of thickened spiral ridges, except for the peripheral keel, but sometimes the dark bands are a little thickened. On the whorls of the spire, however, at least two fine spiral ridges can as a rule be detected with the aid of a hand lens, while in the embryo there are several and even in the adult more than two can be discovered under a high power of the microscope. All these ridges are punctate and when the shell is fresh bear rows of minute chaetae-like processes of the periostracum. The processes are, however, so delicate that they usually disappear as the shell dries.

The embryonic shell differs from that of any form of *V. bengalensis* in its broader, more conical form, in the produced character of the apical whorl and a half and in the very strong peripheral keel of the body-whorl.

The operculum is very thin and of a pale golden brown colour.

The outline is ovate and the external surface broadly concave with the concentric ridges poorly developed. The internal surface

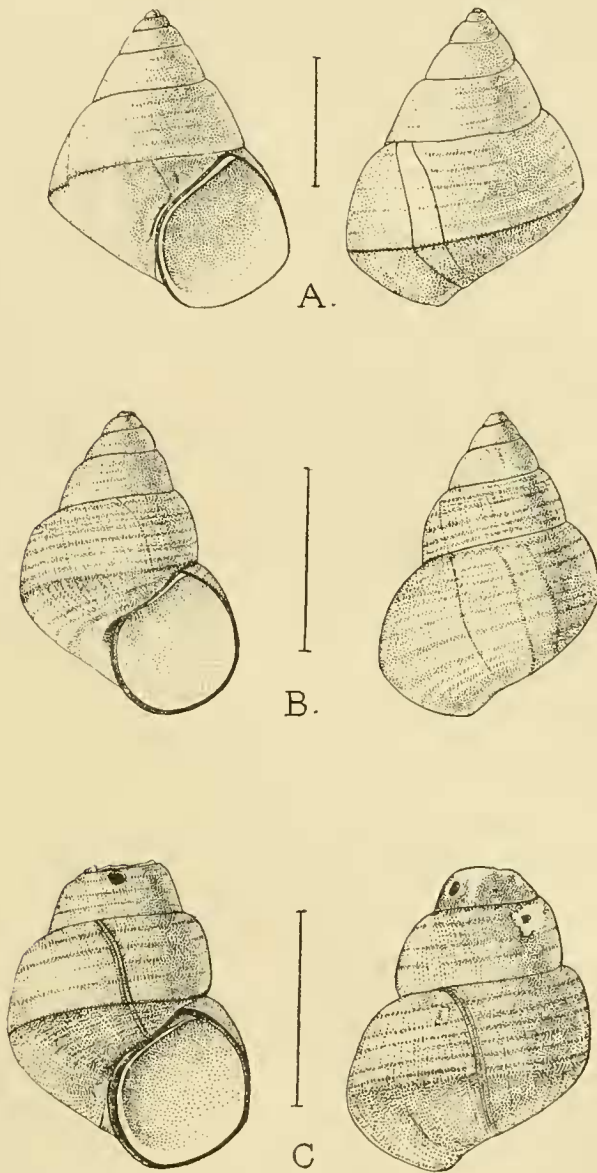


FIG. 4.—Shells of *Vivipara microchaetophora*.

A.—Young shell. B.—Shell of young adult.

C.—Old shell.

is convex as a whole. The muscular scar is poorly developed and only a little darker than the rest of the operculum. It covers a considerable area as a minutely granular thickening.

The radula has the denticulations of the teeth rather numerous and coarse but otherwise offers no particular feature of interest.

The animal offers no noteworthy particular except that it is rather pale in colour. The edge of the mantle is thin and almost smooth in the adult, at any rate in preserved specimens.

*Type-series*.—No. M 11856/2 Zool. Surv. Ind. (*Ind. Mus.*).

*Distribution*.—This species is only known from Dimapur, which lies in the plains of Assam immediately north of the Naga Hills and about 100 miles north of the Manipur valley. Nevill examined specimens from Assam but of unknown provenance.

*Affinities*.—I do not think that this species has any close relationship to the thick-shelled Indo-chinese forms with which Nevill associated it under the name *Paludina bengalensis* var. (or subsp.) *cingulata*. The shells he examined were old and in them the very characteristic sculpture and colouration was obscured. The embryonic shell is so unlike that of *V. bengalensis* and so like that of *V. oxytropis* that I believe *V. microhactophora* to be related rather to the latter species.

*Habits*.—The species was found in artificial ponds, particularly on floating grass-stems and the lower parts of plants that trail on the surface of water. In a rather deep clean pond, with a bottom of stiff yellowish clay and a rather profuse growth of *Hydrilla*, reserved for the water-supply of the Manipur Road railway station and the surrounding houses, large numbers died at the beginning of March, 1920, and by their decay gave the water a horrible ammoniacal smell. In a shallow, swampy pond a few hundred yards away many individuals were observed alive and active.

### *Vivipara oxytropis* (Benson).

(Plate IV, figs. 2-5.)

1836. *Paludina oxytropis*, Benson, *Journ. As. Soc. Bengal* V, p. 745.  
 1852. *Paludina pyramidata*, Küster, Martini and Chemnitz's *Conch. Cab.*, pp. 27, 28, pl. vi, figs. 1, 2.  
 1864. *Paludina oxytropis*, Reeve, *Conch. Icon.*, pl. ii, fig. 9  
 1909. *Vivipara oxytropis*, Kobelt, Martini and Chemnitz's *Conch. Cab.*, p. 132, pl. xxiv, figs. 9, 10.  
 1915. *Vivipara oxytropis*, Preston, *Faun. Brit. Ind. Freshw. Moll.*, p. 84.

The shell is large or very large but thin and delicate, rather broadly conical, acuminate, narrowly perforate, ornamented with prominent spiral ridges, highly polished and of a bright translucent olive-green when clean and fresh. The base is flattened and recedes abruptly below the peripheral ridge of the body-whorl, especially on the ventral surface. There are  $5\frac{1}{2}$  whorls, but the terminal half whorl is minute. The other whorls of the spire increase in size gradually. The suture is very little impressed and all the whorls are broadly but a little obliquely flattened outside it. The body-whorl as seen in dorsal view is transverse, but widens abruptly towards the aperture. It is broadly but obliquely flattened above and not at all tumid. The aperture is subcircular or

broadly oval, slightly narrowed at both extremities. The columellar margin is sharp and narrowly prominent. The umbilicus, though narrow, is circular and is approached from below by a deep and clear-cut channel. The aperture extends for some distance below the apparent base of the shell. The peristome is continuous. The outer lip is thin but not sharp, broadly and regularly arched, with a distinct prominence at the termination of the peripheral ridge. There are two smooth prominent spiral ridges on the three last whorls of the spire, three including the peripheral ridge or keel on the upper part of the body-whorl, and three rather less prominent ridges below the peripheral keel. All these ridges are darkened. Between each pair finer spiral ridges can be detected with a low power lens, crossed at regular intervals by straight, oblique striae, which do not interrupt the stronger ridges. The apex of the spire is darkened and the second complete whorl tinged with chestnut. The interior of the shell is washed with bluish white and the periphery of the aperture narrowly blackened and highly polished.

The female shell is distinctly broader than the male. The embryonic shell is extremely like that of *V. microchaetophora* but considerably larger.

The operculum is thin, relatively large and broadly ovate, bluntly pointed above, of a pale translucent brown colour, almost flat externally, with the concentric ridges feeble, the margin almost membranous and the scar small poorly developed and only slightly darkened. On the peripheral region of the ventral surface radiating striae are well developed.

The radula is distinguished from that of *Vivipara bengalensis* by the much smaller denticulations of the teeth and narrower marginals (fig. 3B).

The animal is like that of *Vivipara bengalensis* (fig. 7B), except for the strong development on the free edge of the mantle in the adult of a number of finger-shaped processes three of which are larger and one much larger than the rest. Each process corresponds to a ridge on the shell and its size is proportionate to the development of the ridge. These processes are concealed in life when the animal is expanded. Their function, as hypertrophied structures, is probably that of accessory breathing organs and may be correlated with the fact that the branchial chamber is often almost completely filled with parasitic leeches (*vide postea*). There is no material difference in the gross internal anatomy of *V. bengalensis* and *V. oxytropis*.

The latter species has frequently been recorded in error from Bengal. The Manipur valley is apparently the only district in which it is common, but I collected some young shells apparently identical in a swampy lake near Kawkareik in the interior of the Amherst district of Tenasserim in 1908.

Two phases can be distinguished in the Manipur valley:—  
(a) the typical phase from the Loktak Lake (pl. IV, figs. 2, 3), in which the shell is normally large and well developed, thin, trans-



lucent and conical, and (b) a pond phase (pl. IV, figs. 4, 5), in which it is usually smaller, thicker, less translucent and less regular in form, and has the mouth narrower and more pointed above. In the latter phase large individuals occur, but they are never of regular trochiform outline and the flattening of the whorls outside the outline is much less oblique. The surface in specimens from ponds is always more or less eroded. The sexual differences in the shell are less marked than in the lake phase.

*Measurements of Shells* (in millimetres).

	Lake Phase.						Pond Phase.						
	♀	♀	♀	♂	♂	♂							
Height ..	..	37	40	35.5	41.5	37	39.5	40	31.5	31	34.5	29	30
Max. diam. ..	..	31.5	35	31.5	32.5	28.5	33.5	33.5	23	26.5	24.5	22.5	21
Height of spire ..	..	17	20	16	21.5	17	17.5	15	14	13.5	16.5	15.5	14
Height of mouth ..	..	20.5	22	21	22.5	18	21	22.5	16.5	17	17.5	15	14.5
Max. diam. of mouth..	..	17	19	16	17.5	15	17	17	12.5	14	12.5	11.5	12

Thus in the lake phase the shell is about  $1\frac{1}{8}$  times as high as broad in females and  $1\frac{1}{5}$  times in males, whereas in the pond phase, in which sexual differences are concealed by individual variability, the height is from  $1\frac{1}{6}$  to  $1\frac{2}{3}$  times the breadth.

The pond phase comes nearer *V. microchaetophora* than does the lake phase and has in all respects a less peculiar shell, nearer that of the Viviparæ bengalenses, from which the Viviparæ oxytropides are perhaps derived. The Japanese form that has been assigned by some authors to the Manipur species has, as Pilsbry has pointed out, no relation to it.

*V. oxytropis* attains its maximum development and most characteristic form in the more open parts of the Loktak Lake, in which it is abundant with *Lecythoconcha lecythis*. In ponds it is much scarcer and it is apparently absent from the smaller swamps of the Manipur valley.

In the lake it is almost invariably infested by a leech of the genus *Glossosiphonia*, which often exists in the branchial cavity in such numbers as to occupy practically the whole lumen. Major Sewell, moreover, found Trematodes of the genus *Leucochloridium* encysted in the mantle of specimens brought living to Calcutta for examination.

Males in this mollusc seem to be considerably less abundant than females, at any rate in the Loktak Lake. The young are more numerous and smaller than those of *L. lecythis* living in the same conditions.

VIVIPARÆ DISSIMILES.

*Vivipara micron*, sp. nov.

The shell is of very small size, moderately thick, acuminate, narrowly rimate, with the spire and the upper part of the body-whorl somewhat elongate but the basal part very short and convexly flattened from below upwards. There are probably  $4\frac{1}{2}$  whorls in the complete shell, but in the only specimen I have



examined the apex is eroded. The whorls of the spire are convex and transverse, narrowly and somewhat obliquely flattened above, and increase in size evenly but rapidly. The suture is deeply but narrowly impressed. The body-whorl is almost trumpet-shaped as seen from the dorsal surface but with the mouth deeply depressed. Its periphery is subangulate and the area beneath the imperfectly developed keel is very broadly triangular with the apex of the triangle on the inner margin. The upper part of the body-whorl is tumid, but below the peripheral angle, which is better developed than on the closed surface, the base recedes abruptly and is only slightly convex. The aperture is rather small, but relatively broad, oblique in both planes, subrhomboidal and distinctly angulate on the inner margin, bluntly pointed above and narrowly rounded below. The outer lip is thin, broadly and a little irregularly arched. The columella is nearly straight. Its fold is fairly prominent and slightly reflexed over the narrow

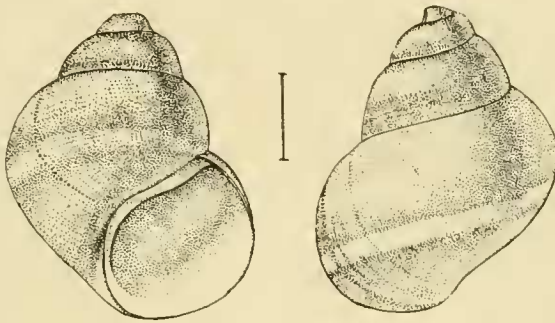


FIG. 5.—Type-specimen of *Vivipara micron*.

umbilicus. The peristome is complete. The colour is a rather pale olive-green, tinged with chestnut on the upper part of all the whorls and more deeply so over the whole apex. There is a broad pale band running round the periphery of the body-whorl. The margin of the mouth is very narrowly blackened and the interior of the shell is tinged with white. The sculpture consists of rather coarse longitudinal curved striae crossed by much finer punctate or sinuate spiral striae. The latter are more conspicuous on the spire than on the body-whorl.

*Measurements (in millimetres) of Type-shell.*

Height	..	..	..	12
Max. diam.	..	..	..	9
Height of spire (dorsal)	..	..	..	4.5
Height of mouth	..	..	..	6.7
Max. diam. of mouth	..	..	..	5.25

*Type-specimen.*—No. M 11855/2 Zool. Surv. Ind. (Ind. Mus.).

*Locality.*—A single empty but fresh shell was collected by Mr. Sundar Lal Hora in Manipur.

*Affinities.*—In spite of its small size this shell does not look like a young specimen of the genus, for the shape is too elongate, the peripheral keel too poorly developed and the aperture too complete. There can be little doubt that it belongs to the group to which I have assigned it, but it is unlike any of the Indian or Burmese forms with which I have been able to compare it by means of either specimens or figures. On the whole it seems to be nearer *V. ceylonica* (Dohrn) than any other, but the shape is much less conical and the base more flattened than in any form of that species.

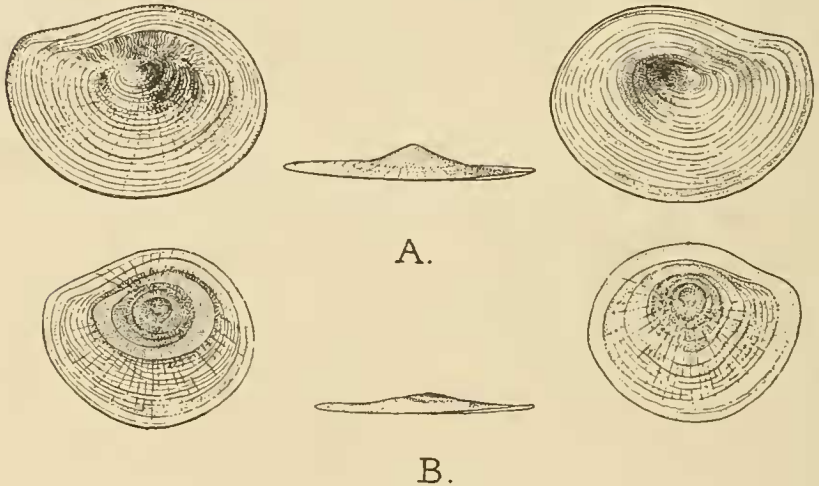


FIG. 6.—Opercula of *Lecythoconcha* and *Vivipara*. A.—*L. lecythis* (nat. size).  
B.—*V. oxytropis* (nat. size).

### *Lecythoconcha*, Annandale.

1920. *Lecythoconcha*, Annandale, *Rec. Ind. Mus.* XIX. p. 114.

*The shell* is of large, sometimes of relatively gigantic size, but thin, smooth or more or less translucent. It is globose in form, with broad swollen whorls, and often bears a striking superficial resemblance to that of *Pachylabra* (Ampullariidae). The colour is uniform or very nearly so and dark spiral bands are never present. The aperture is large and patent, subcircular or broadly suboval. The columellar fold is not strongly developed, the umbilicus is narrowly perforate and the outer lip is thin.

*The operculum* is large, thin but stiff and rather brittle. Externally it is marked with strong but sharp concentric ridges and bears in its central region a deep funnel-shaped pit. There is no muscular scar on the internal surface but the pit is represented by a prominent rounded boss, round which there may be a ring-shaped area on which the surface is slightly roughened.

The animal differs from that of *Vivipara* in the greatly thickened and highly muscular free edge of the mantle, the sphincter muscle running along which is very strong and conspicuous. The radula is identical with that of *Vivipara*.

*Type-species*.—*Paludina lecythis*, Benson.

*Geographical Range*.—The range of the genus probably extends from the Manipur Valley through Upper Burma and possibly Tenasserim to Yunnan and Cochin China and thence across China to the Philippines, Celebes, Formosa and Japan. But I am not quite sure as to the generic identity of some of the Far Eastern species. In all those from China and Japan I have examined (except specimens of the type-species from Yunnan) the operculum differs in having the ring-shaped area round the central boss on the internal surface much more strongly roughened and scar-like than in *L. lecythis*.

Anatomically the new genus closely resembles *Vivipara*, as, indeed, do all the Asiatic genera of the family, but the structure of the mantle-edge and its sphincter is characteristic.<sup>1</sup>

The strong mantle-sphincter has probably a definite function to perform, viz. that of protecting the branchial chamber from the entry of parasites.<sup>2</sup> As my assistant Mr. Amin-ud-Din pointed out to me at the Loktak Lake, almost every specimen of *Vivipara oxytropis* we examined there was infested by a leech of the genus *Glossosiphonia*, over 30 individuals of which were sometimes found in the branchial chamber of a single specimen, while the branchial chamber of *Lecythoconcha* from precisely the same habitat was invariably empty. The contraction of the powerful muscle must close this chamber much more effectively than that of the comparatively feeble muscle in *V. oxytropis*.

### *Lecythoconcha lecythis* (Benson).

(Plate V and plate VI, figs. 1, 2.)

1850. *Paludina lecythis*, Benson, *Journ. As. Soc. Bengal* V, p. 745.  
 1852. *Paludina ampulliformis*, Eydoux and Souleyet, *Voy. 'Bonite,' Zool.*, p. 549, pl. xxxi, figs. 25-27.  
 1876. *Paludina lecythis* and var. *ampulliformis*, Hanley and Theobald, *Conch. Ind.*, pl. lxxvi, figs. 6, 7.  
 1877. *Paludina chinensis* varr. *ampulliformis* and *lecythis*, *P. siamensis* (in part), Nevill, *Cat. Moll. Ind. Mus. E.*, pp. 25, 36.  
 1885. *Paludina chinensis* varr. *ampulliformis* and *lecythis*, *P. siamensis* var. *burmanica*, id., *Hand List Moll. Ind. Mus. II*, pp. 20, 26.

The shell is of large or very large size, thin, of a uniform olive-green when fresh but often fading to brown, globose, narrowly perforate. There are  $4\frac{1}{2}$  or 5 whorls. The apex is acuminate

<sup>1</sup> Annandale, *Rec. Ind. Mus.* XIX, p. 114, fig. 3 (1920).

<sup>2</sup> Major R. B. S. Sewell found the mantle of both *L. lecythis* and *V. oxytropis* from the Loktak Lake and ponds at Imphal infested with an encysted Trematode (*Leucochloridium*), but the orifice of the cyst was always on the external surface of the mollusc. I have found a minute parasitic mite among the gill-filaments of *L. lecythis*.

and the spire as a whole conical, but with the whorls tumid and flattened above and the suture deeply impressed. The spire, measured on the dorsal surface, is about as high as the central part of the body-whorl on the same surface. In this view the body-whorl is oblique and spiral and is considerably more than twice as deep at its outer as at its inner margin. The whorl is somewhat compressed from above downwards but strongly convex. In ventral view the spire is somewhat shorter than in dorsal view and the body-whorl, without the mouth, forms almost an equilateral triangle the apex of which is directed downwards. The upper part of the whorl is greatly swollen but it recedes inwards towards the umbilicus somewhat abruptly. The aperture is large and patent, more or less oblique and broadly oval. The outer lip is sharp and more or less narrowly tinged with black. The columella is arched and

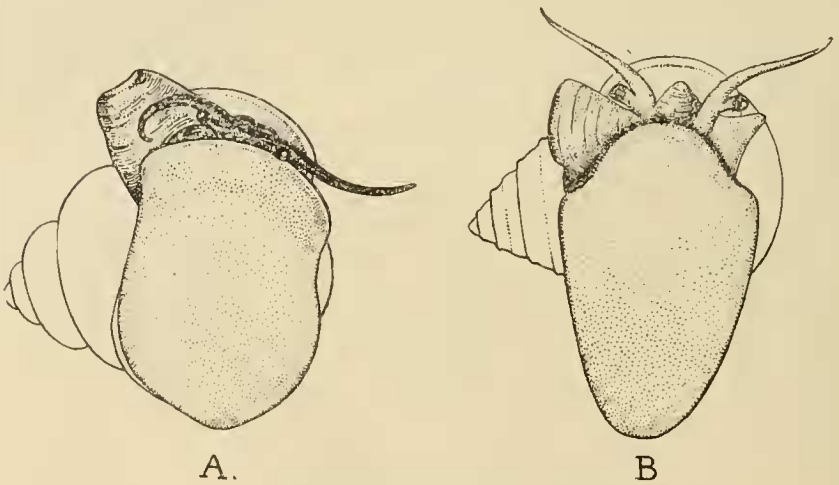


FIG. 7.—Living animals of *Lecythoconcha lecythis* ♂ (A) and *Vivipara oxytropis* ♀ (B). Nat. size.

its folds form a prominent ridge which is very little reflected over the umbilicus. This ridge is highly polished and of a bluish white colour, with which the whole interior of the shell is more or less deeply tinged. The sculpture consists of numerous fine, almost straight longitudinal ridges and frequently of close-set irregular indentations which give the whole shell a malleated appearance. These are more commonly present on the penultimate than on the body-whorl. In immature specimens a blunt ridge runs round the periphery of the latter whorl and even in large shells this is sometimes represented by a fine line, which may bear very fine cilia-like processes of the periostracum.

The female shell is a little more globose than the male and has the outline of the spire less broken (*cf.* figs. 1, 2, pl. V).

The operculum is thin and transparent, but hard and rather brittle, of a deep uniform golden brown colour and distinctly

pyriform. The central boss on the internal surface is situated nearer the inner than the outer margin. It is highly polished but its base is marked with fine radiating, iridescent ridges. The area surrounding it is smooth, but fine radiating lines proceed down on it from the boss.

The radular teeth are figured in fig. 3, on p. 544. They exhibit no essential difference from those of *Vivipara*.

The animal has the generic characters. It is rather less brightly coloured than most species of Viviparidae, the body being sooty black and the minute spots with which it is covered being dull yellow and very small. The tentacles are very long and thin and the foot is remarkably stout. Fig. 7 shows the outstanding differences between the living animal and that of *V. oxytropis*, which in most respects is a typical *Vivipara* so far as the soft parts are concerned.

*Type-specimens*.—No. 2300 Zool. Surv. Ind. (*Ind. Mus.*).

*Geographical Range*.—The type-specimens from the Asiatic Society's collection are labelled as being from Sylhet, but they agree so closely with shells from the more open part of the Loktak Lake<sup>1</sup> that I think this locality is probably incorrect. The species is not represented, so far as I am aware, in any recent collection from Sylhet and it must be remembered that at the time when Benson's collection was made Sylhet was on the way to Manipur. The true range probably extends from the Manipur Valley through Upper Burma to the Southern Shan States, Yunnan and Cochin China. Nevill records young specimens from the Philippines, but in view of their immaturity the record is open to doubt.

In Manipur no less than four phases can be distinguished, one of which, at one end of the series, is the *forma typica*, while another, at the other end has received the varietal name *ambulliformis*. I shall describe the phases under English names.

**THE OPEN-WATER PHASE** (= *forma typica*): plate V, figs. 1, 2. The shell is very large, globose, thin and translucent and is of a bright olive-green colour externally and only slightly washed with bluish white internally. The aperture is subcircular, the outer lip strongly arched and very thin. The sculpture is very fine and delicate and if varices occur on the body-whorl, as is often the case, they are poorly developed and as a rule not blackened. This phase is found in the more open parts of the Loktak Lake.

**THE MARGINAL PHASE**: plate V, fig. 3. The shell is thicker, heavier, more opaque and coarser than in the last phase and, though individuals grow at least as large, is usually smaller. The spire is relatively longer and not quite so broad at the base, the whorls are not quite so convex and the aperture rather

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<sup>1</sup> Specimens of this phase are not difficult to obtain as they are brought up in hundreds by the fishermen in their nets. I have to thank Mr. C. Forster Cooper, Superintendent of the Cambridge University Museum, for examining the specimens in the Benson collection. He informs me that they also are labelled "Sylhet."



smaller. The lip is not so thin and has a deeper black border. The sculpture is much coarser and blackish varices can usually be detected on the body-whorl. This phase is abundant in the swamp at the north end of the Loktak Lake.

THE POND PHASE: plate VI, figs. 1, 2. The shell is smaller than in either of the last two phases but more variable both in size and shape. It is decidedly narrower than either and has the spire relatively longer, the whorls less tumid and less broadly flattened above. The mouth is variable in outline but as a rule is distinctly emarginate above the umbilicus. The sculpture is coarse and irregular and the shell more liable to erosion on the surface. This phase is found in ponds and in the smaller swamps of the Manipur Valley. Many of the specimens collected by the late Dr. John Anderson in Upper Burma and Yunnan also belong to it.

THE RICE-FIELD PHASE. (=var. *ampulliformis*, Eydoux and Souleyet): plate V, fig. 4. This is a small phase in which the upper part of the whorls of the shell is much less distinctly flattened, the spire is relatively long and the whole shell comparatively narrow. Some specimens of the pond phase approached it very closely. It is common in small pools in the rice-fields of the Manipur Valley and preponderates among the specimens collected by the late Dr. John Anderson in Upper Burma and Yunnan. It has also been recorded from Cochin China and appears to be, as might be expected, the most widely distributed phase of the species.

*Habitat and Habits.*—The concluding sentences of the preceding paragraphs indicate in a general way the habitats of the different phases, which are also indicated in the names given to them. There is one further point of interest to be noted, namely that the rice-field phase is peculiarly resistant to desiccation. A specimen was found in dry mud in February and brought to Calcutta dry. In cleaning the shell more than a month later the operculum was removed and the animal found to be in a perfectly fresh condition though quite immobile and apparently insensible.<sup>1</sup> It was accidentally left for the night in a dish of water and gave birth to a number of living young. It survived itself for several days, in spite of the removal of its operculum, but, probably on account of its injuries, did not regain sensibility.

No other noteworthy difference was observed between the habits of this species and those of *Vivipara bengalensis* and its allies.

The shells from Upper Burma and Tenasserim called *Paludina siamensis* var. *burmanica* by Nevill are merely young specimens of this species, as is evident from a direct comparison and from an

<sup>1</sup> The condition of this mollusc was apparently the same as that of a specimen of *Pseudovivipara hypocrites* examined after being dry two years and after a journey from China to Calcutta and from Calcutta to England and back. See *Mem. As. Soc. Bengal* VI, p. 312.

examination of their opercula. Probably the true *Paludina siamensis* of Frauenfeld is also the young of some allied species.

Family AMPULLARIIDAE.

Genus *Pachylabra*, Swainson.

The use of the name *Pachylabra* for the Oriental and African species of Ampullariidae has been discussed by Kobelt in the current edition of Martini and Chemnitz's *Conch. Cab.*, pp. 44-46 (1911). The genus is distinguished from the American *Ampullaria* by the structure of the operculum and the inhalent siphon. The former in *Pachylabra* is massive and calcareous with a coarse external horny covering. The siphon when contracted is a prominent fold forming an incomplete tube not very much longer than its transverse diameter. When expanded it is a funnel-shaped structure, considerably broader than long.

This genus is represented in the Manipur Valley by a single species (*P. maura*, Reeve), which is common throughout the plains of Assam. In the Manipur Valley, however, it was found only in a few ponds in the immediate vicinity of the capital. The question naturally arises, may it not have originally been introduced by man, either as food or accidentally? The Manipuris even now eat some kinds of molluscs and the Naga tribes of the surrounding hills are fond of all the larger freshwater species. *P. maura*, however, is well within the geographical limits of its range in Manipur, for it is found in the valley of the Brahmaputra on the one hand and on the Shan Plateau on the other.

*Pachylabra maura* (Reeve).

1856. *Ampullaria maura*, Reeve, *Conch. Icon.*, pl. xiii, fig. 57.  
 1887. *Ampullaria maura*, Nevill, *Cat. Moll. Ind. Mus.* E, p. 5.  
 1885. *Ampullaria maura*, id., *Hand List Moll. Ind. Mus.* II, p. 4.  
 1918. *Ampullaria winkleyi*, Annandale (*nec* Pilsbry), *Rec. Ind. Mus.* XIV, p. 138, pl. xii, fig. 10.

My identification of specimens from the North Shan States as *A. winkleyi* was certainly incorrect and I can find no constant difference between them and shells from Assam except that they are paler and brighter in colour. Of the true *A. winkleyi* I have recently examined a shell from Patalung in Peninsular Siam.<sup>1</sup> Its minute spiral sculpture is much better developed and its shape different.

All the specimens examined from Manipur are small and have the shell very dark. They agree, however, precisely with some individuals from Dimapur and from Gauhati on the Brahmaputra.

The species is probably no more than an eastern race of *P. globosa* (Swainson), the common Ganges species. Nevill, however (*op. cit.*, 1887, p. 5), keeps it distinct on account of its "wider umbilicus, more contracted aperture with dark-coloured margins, more produced spire and thinner shell." I doubt whether these differences will be found to be constant, but until the Indian species

<sup>1</sup> Annandale, *Journ. Nat. Hist. Soc. Siam* IV, p. 45 (1920).

of the genus have been revised, it seems best to regard it provisionally as a species. I figure the radular teeth.

In Manipur *P. maura* was found (in February and March) buried in the mud at the edge of certain ponds in or near Imphal, the capital. Dead shells were also found round these ponds, but not elsewhere in the valley. In the garden of the Residency the species was fairly abundant in one of two ponds, but not in the other. Both were shallow and had a dense submerged vegetation

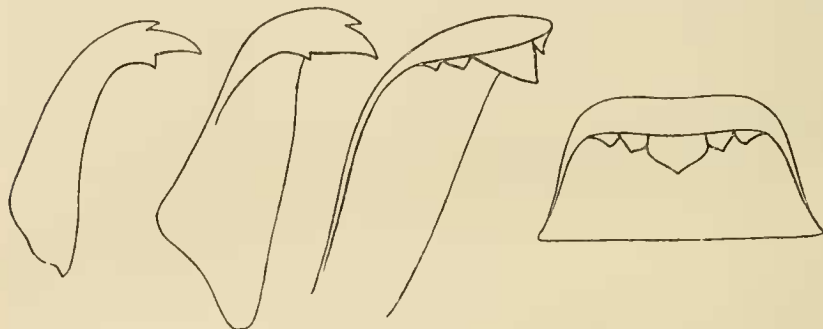


FIG. 8.—Radular teeth of *Pachylabra maura*.

of *Potamogeton* and *Hydrilla*, with a not very dense floating vegetation of *Azolla*, etc. The only difference seemed to be that in the pond in which *Pachylabra* occurred lotuses had been planted, and that there were none of these plants in the other. The other ponds in which the mollusc was found had a still richer submerged and floating vegetation with a profuse growth of plants that sent out long runners on the top of the water. Most species of the genus are dependent for their food on succulent leaves and stems and prefer such vegetation to the ordinary submerged water-weeds.

#### Family MELANIIDAE.

##### Subfamily MELANINAE.

##### Genus *Melanoides*, Olivier (*nec* H. and A. Adams).

1807. *Melanoides*, Olivier, *Voyage l'Emp. Ottoman* II, p. 40.  
 1854. *Plotia*, *Tarebia*, H. and A. Adams, *Gen. Recent Moll.*, pp. 295, 304.  
 1874. *Plotia*, *Tarebia*, *Striatella*, Brot, *Conch. Cab.*, p. 7.  
 1897. *Stenomelania*, *Tarebia*, *Melanoides*, *Plotia*, von Martens, in Weber's *Zool. Ergebn. Niederl. Ost. Ind.* IV, pp. 40, 50, 62, 69.  
 1898. *Neomelaniien* (in part), P. and F. Sarasin, *Sussw. Moll. Celebes*, p. 38.  
 1915. *Radina*, *Striatella*, *Melanella* (in part), *Tarebia*, *Plotia*, Preston, *Faun. Brit. Ind., Freshw. Moll.*, pp. 10, 15, 32, 33, 35.  
 1919. *Melanoides*, Annandale and Prashad, *Rec. Ind. Mus.* XVIII, p. 28.  
 1920. *Melanoides*, Annandale, *ibid.*, XIX, p. 108.

In the paper by Dr. Bains Prashad and myself cited immediately above we have given reasons for uniting *Melanoides*, s.s. and *Plotia*. Our views on this point are further strengthened by an examination of a large collection from various parts of the Madras

Presidency. In it I find all intermediate stages between the typical *M. scabra* (Müller) and *M. acanthica* (Lea) in the one direction and between *M. scabra* and the form we called *M. pyramis* var. *puteicola* on the other. The only constant difference that can now be claimed between *M. scabra* and *M. pyramis* as species is that in the former the lip of the shell is always strongly sinuate, its upper extremity as seen in ventral view being situated at a somewhat lower level than that of the columellar margin, though the central part of its margin lies level. This, as is shown in our original figures of the var. *puteicola*, is a marked feature of that form. The variety must, therefore, be retransferred to *M. pyramis*, with which Nevill originally associated it, and known as *M. scabra* var. *puteicola*. I can find no justification for separating *Tarebia* generically from forms like the typical *M. scabra*.

#### Melanoides tuberculatus (Müller).

1919. *Melanoides tuberculatus*, Annandale and Prashad, *op. cit.*, pp. 29, 31, fig. 3A, pl. iv, fig. 1.

Specimens from Manipur have no striking peculiarities. The species is common in ponds in the valley but was not found in the Loktak Lake.

The processes on the edge of the mantle arise on the ventral surface a short distance behind the actual margin. The largest is situated on the left side and they grow smaller as the series proceeds towards the right.

#### Genus Acrostoma, Brot.

1854. *Melanoides*, H. and A. Adams (*nec* Olivier),  
 1874. *Melanoides, Acrostoma*, Brot. *Conch. Cab.*, p. 7.  
 1897. *Brotia*, von Martens, in Weber's *Zool. Ergebn. Niederl. Ost. Ind.*  
 IV, p. 33.  
 1915. *Melanoides, Acrostoma*, Preston, *Faun. Brit. Ind., Freshw.-Moll.*  
 pp. 21, 30.  
 1920. *Acrostoma*, Annandale, *Rec. Ind. Mus.* XIX, p. 109.

I cannot find any constant difference between the shells, opercula, soft parts or radulae of *Brotia*, von Martens (= *Melanoides*, auct.) and *Acrostoma*, Brot. Indeed such forms as the one described here as *Acrostoma variabilis* var. *laevis*, though clearly falling within the limits of *Brotia*, are very closely related to *A. hugeli*, the type-species of *Acrostoma*.

In this genus some of the heaviest shells among the freshwater Gastropods occur.

The edge of the mantle of *A. variabilis*, in living individuals as in preserved specimens, is quite smooth. It is marked out, however, on the inner surface into well-defined areas by vertical lines of bright yellow pigment on a dark background. In preserved specimens of *A. hugeli*, the type-species of the genus, a similar condition is found. There is no difference in this respect between individuals of *A. variabilis* with smooth and those with highly sculptured shells.

*Acrostoma variabilis* (Benson).

(Plate VI, figs. 3—6.)

1830. *Melania variabilis*, Benson, *Journ. As. Soc. Bengal* V. p. 746.  
 1872. *Melanoides spinata*, Godwin-Austen, *Proc. Zool. Soc. London*,  
 p. 514, pl. xxx. figs. 1, 1a.  
 1876. *Melania variabilis, episcopalis, spinata*, Hanley and Theobald,  
*Conch. Ind.*, pl. lxxii, fig. 7. pl. lxxv. figs. 5-7. pl. cix. figs. 1, 3,  
 6.  
 1885. *Melania variabilis, spinata*, Nevill, *Hand List Moll. Ind. Mus.*  
 pp. 251-261.

This justly named species is represented in the Manipur Valley by three varieties which link together several forms that have sometimes been regarded as distinct species. The varieties, however, are by no means constant, though even quite young shells can usually be distinguished for many intermediate individuals occur. The three Manipuri forms may be called *laevis*, var. nov.

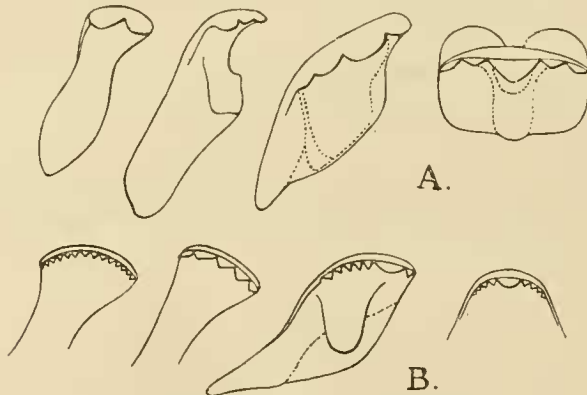


FIG. 9.—Radular teeth of Melaniidae.

A. *Acrostoma variabile*. B. *Paludomus pustulosa*.

*semilaevigata*, Nevill and *subspinata*, var. nov. I will describe each separately. Here I figure a living specimen of the var. *subspinata*, nov., from Dimapur, to show the form of the animal.

Var. *laevis*, nov. : pl. vi, figs. 3, 4. Under the name *semilaevigata* Nevill included two forms which seem to me to be distinct varieties. In one of them, for which I propose the name *laevis*, the shell is often almost as smooth as that of *Acrostoma hugeli*, the longitudinal ribs being completely obsolete, while in other shells I assign to the same variety they are only obsolescent and may even be produced into a small tubercle at the upper extremity. This may occur either on both the two last whorls or on the penultimate whorl only. The longitudinal sculpture in the smoothest shells consists merely of coarse striae, while the spiral sculpture is represented by ill-defined smooth ridges. The most highly sculptured shells of this variety approach the var. *pseudospinosa*, Nevill.

Var. *semilaevigata*, Nevill: pl. vi, fig. 5. In Nevill's type-



series of this variety I find shells of the form here called *laevis* mixed with others to which the definition he adopted from Benson applies more exactly, the essential difference being that in the obsolescent ribs of *semilaevigata* both extremities are produced into tubercles. Highly sculptured shells of this variety often approach Nevill's var. *binodulifera*.

Var. *subspinata*, nov.: pl. vi, fig. 6. This form is interesting as being precisely intermediate between the var. *binodulifera*, which occurs in abundance in the river at Dimapur just north of the Naga Hills, and Godwin-Austen's *Melanoides spinata* from northern Assam. The two rows of spines are nearer together than in *binodulifera* and the spines are more produced, but they are not foliaceous as in *spinata*.

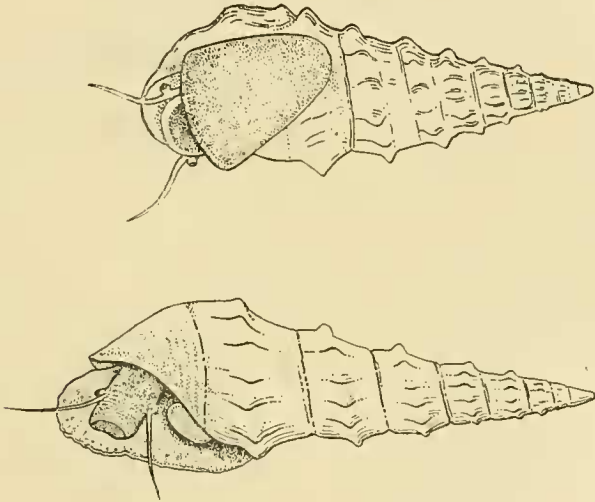


FIG. 10.—Living animal of *Acrostoma variabilis* var. *subspinata*, nov., from Dimapur, Assam.

These three varieties are, as I have said, by no means constant. The two last occur together and in most individuals can be readily distinguished even before the shell has attained a third of its full dimensions, the longitudinal ribs being well developed in this stage as strong keels on all but the first four or five whorls in *subspinata*, while the whole shell is smooth in *laevis*. Intermediate individuals occur, however, not uncommonly. They are much commoner among adult than among young shells. The vars. *laevis* and *semilaevigata* also occur together, but I have not found both *semilaevigata* and *subspinata* in any series examined. This would suggest that the smooth type of shell has been derived independently along two lines, by the suppression of the lower part of the ribs in one line and by that of the middle region in another.

The young shell removed from the oviduct at full time is identical in all the Manipuri varieties. It consists of  $4\frac{1}{2}$  whorls and is conical in outline with the base produced towards the outer margin and pointed. The apex is minutely blunted and retracted, the apical half-whorl lying in a deeply canaliculate suture. Round the other whorls the suture is not impressed. The aperture is regularly rhomboidal, narrow, oblique and somewhat elongate. The colour is pale olivaceous green becoming darker and browner towards the apex, which is infuscated. A dark brown spiral band embraces both sides of the suture and is continued round the periphery of the body-whorl, on which a second band of the same colour appears towards the base.

The sculpture consists of microscopic spiral and longitudinal striae. The latter are strongly curved. There is an obscure, flattened spiral ridge running just below the suture and round the periphery of the body-whorl.

The Manipuri varieties have much thicker and heavier and, generally speaking, larger shells than the *forma typica*, which is common in ponds in the Gangetic delta. This seems to be so in all fluviatile phases of the species. In Manipur the varieties occur in the beds of the Imphal River and its tributaries, in muddy water and on a muddy bottom. Apparently they are not found in the swifter, clearer hill-streams.

The range of *A. variabilis* as a species extends eastwards from the Gangetic Delta, through Assam and Burma and it is represented in the Malay Peninsula, Sumatra and Java by very closely allied forms. Its "varieties" may be mere phases the peculiarities of which are due to some peculiarity (or rather combination of peculiarities) in the environment, but on this subject little is yet known. The animal is usually if not always found on a muddy bottom and obtains its food by scraping the surface with its radula.

#### Subfamily PALUDOMINAE.

#### Genus *Paludomus*, Swainson.

The number of the species and subspecies of this genus found in Burma and Assam is probably considerable, and some species from these countries, notably *P. conica* (Gray), are particularly liable to form local races. Indeed, specimens of *P. conica* seem to differ slightly in every stream in which they occur. The whole genus stands, however, in need of revision as far as any rate as the Indian forms are concerned, and it is important that young as well as adult shells should be examined, for in maturity the spire is often so distorted by erosion that the true form of the shell completely disappears. I have been unable to match a *Paludomus* fairly common in the southern part of the Manipur Valley with any previously described and am therefore obliged to call it new. Fortunately shells in all stages of development are available.

*Paludomus pustulosa*, sp. nov.

The shell when fully adult is thick and porcellaneous and of a uniform blackish colour externally. Only the body-whorl and part of the penultimate whorl usually remain. The former is tumid, very oblique and more than twice as deep at its inner than at its outer margin as seen from the dorsal surface. The inner margin is very broadly rounded. On the ventral surface the whorl has an elongate, irregularly oval outline. On the outer side it is highly convex above but recedes rather abruptly to-

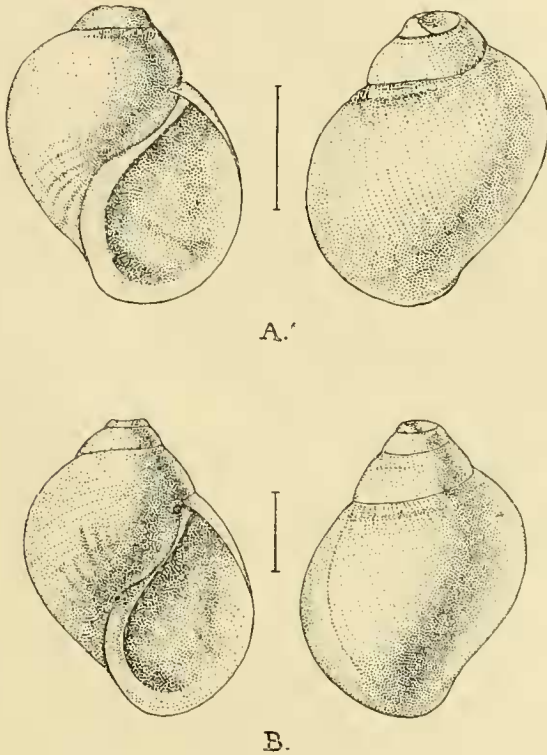


FIG. 11.—Shells of *Paludomus pustulosa*.  
A. Adult shell. B. Half-grown shell.

wards the lower margin. On the inner side the region above the aperture is short and convex. The ventral surface is swollen above, somewhat flattened below. The mouth projects obliquely at its upper end. It is slightly pyriform, rather narrow and oblique. The upper extremity is sharply pointed, the lower evenly and not very broadly rounded. The lip is thin, slightly everted and obscurely pleated internally. It forms a well-defined margin to the aperture and is highly polished and of a bluish white colour with a narrow black border. The columellar margin is similar in appearance and forms a continuous ridge with the

lip. This ridge is, however, broadly excavated above the columella. There is hardly any trace of the umbilicus. The sculpture consists of fine and regular longitudinal striae with coarser longitudinal lines set at irregular intervals and of minute, almost microscopic pustule-like granules scattered irregularly and sometimes confined to the ventral surface. Round the upper part of the whorl, and sometimes also at its base, there are traces of several obsolescent transverse grooves. The interior of the shell is olivaceous, sometimes with traces of two or three broad chestnut bands.

Half-grown shells are very different in appearance. They have at least  $3\frac{1}{2}$  whorls and sometimes traces of a fourth. The outline is rather narrowly ovate with the spire tapering and rather narrow but blunt at the tip. The colour is dark olivaceous green or brown with the internal bands more distinct and the shell is much thinner. The whorls of the spire increase evenly but rapidly in size and are flattened above, with two or more rather deep grooves running round the upper surface. Without intermediate individuals I would hardly have thought these two types of shell specifically identical, but the series collected by Mr. Sunder Lal Hora leaves no doubt on the point.

In very young shells, not more than 5 mm. long, there are 5 whorls and the apex is acuminate.

The *operculum* is of the type normal in *Paludomus*, s.s., being of ovate form with a small spiral figure situated in the anterior inner region.

The *radula* does not differ materially from that of *Melanoides*, except that the outer lateral and the marginal are more spatulate (fig. 9B).

*Type-series*.—No. M 11855/2 Zool. Surv. Ind. (*Ind. Mus.*).

*Localities, etc.*—Specimens were obtained by Mr. Sunder Lal Hora from one stream in the south part of the Manipur Valley. Specimens were also purchased, with those of *Vivipara crassispinalis* in the Imphal bazaar, but were said to have come from the same district. Mr. Hora obtained his specimens on a pebbly bottom in clear, rapid-running water.

*Affinities*.—The species is closely allied to *P. conica* (Gray) and especially to the race *kopiliensis*, Nevill, from northern Assam. The sculpture is, however, more delicate and the body-whorl as seen in ventral view considerably more elongate. Of the shells figured in the *Conchologia Indica* the nearest is *paludinooides*, Reeve (pl. cxxiii, fig. 9), but the aperture in my new species is more oblique, longer and narrower, the inner outline more irregular and the colour much duller and darker. The young shell is not unlike the figure of *clavata* (fig. 4) from Ceylon on the same plate, but its aperture is much larger and more patent.